

paene ad apicem breviter ciliata ut phyllaria cetera dense cinerascens pilosula pilis appressis; omnia margine et apice saepe purpureo-tincta. Corollae purpureae ca. 8 mm longae, saltem exteriores horizontaliter patentibus tubo stamineo et stylo sursum curvatis; tubus tenuis ca. 2.5 mm longus glaber; faux campanulata ca. 2.5 mm longa glabra; dentes apice recurvati dorso prope apicem praecipue juventate stipitato-glandulosi, ei labii exterioris 3 mm ei labii interioris 2 mm longi. Achenia valde immatura ca. 1 mm longa 1.5 mm lata (alis tenuibus ca. 0.25 mm latis inclusis) truncata glabra. Pappi albi setae ca. 56, exteriores ca. 1.5 mm interiores 3 mm longae.

COLOMBIA: Erect succulent herb to 2.5 meters high, flowers purple, showy, in dense colonies on masses of broken limestone in forest 5 km south of Codazzi, Dept. Magdalena, alt. ca. 150 meters, 31 Oct. 1943, *Oscar Haught* 3796 (type no. 1708581, U. S. Nat. Herb.).

The proper position of this plant in the tribe Vernoniae is not easy to determine. Benth and Hooker's series Ethuliae, containing 11 genera, was separated from their series Euvernoniae, containing 6 genera, by no definite character aside from the pappus. In the Ethuliae the pappus was described as absent or composed of very caducous and usually few bristles, in the Euvernoniae as more or less persistent and usually 2-3-seriate, with copious inner bristles. Hoffmann, in *Die natürlichen Pflanzenfamilien*, split the Ethuliae into two groups, the first without pappus, the second with a pappus of caducous ("leicht abfallenden") bristles, but did not assign them the dignity of series names. In this, as in some simi-

lar cases in other groups of Compositae, it is not too easy to discriminate between a caducous pappus, one that is fragile and readily deciduous, and one that is definitely persistent. Moreover, some species of *Vernonia* and related genera of the Euvernoniae possess a pappus that is quite as fragile and as readily deciduous as that of *Erlangea* and *Blanchetia* (of the Ethuliae).

For the present the genus may be placed after *Vernonia*. It differs primarily from that genus, as from all other known Vernoniae, in its truly winged and strongly obcompressed achenes. Its bilabiate corollas and curiously appendaged phyllaries are additional points of distinction. The presence of an outer lip made up of two petals instead of three is certainly very rare in Compositae, but repeated and careful dissection seemed to leave no doubt of its reality.

The immature state of the achenes makes a complete description of their characters impossible. Those of the two or three outer series of flowers are normally although not invariably winged as described; the very immature inner achenes show no evidence of a wing. Several instances of connation between two ovaries of the same series, and in two cases even between three, were observed in the material dissected; these immature fruits were much broader than normal ones and showed two circles (in two cases three) of more or less completely detached pappus bristles at apex. In one instance two corollas were found in place on a double ovary, and in another three embryos, one much smaller than the others, were found in place in a triple ovary.

ENTOMOLOGY.—*The mealybug genus Heterococcus Ferris and some of its relatives (Homoptera: Coccoidea).*¹ HAROLD MORRISON, Bureau of Entomology and Plant Quarantine.

First described in 1918 by Ferris (4, p. 65), *Heterococcus* has attracted little attention in the years since its description, and only a few species have been assigned to it during this time. In fact the genus has been so infrequently recognized that for most of this period no examples of any species belonging to it have existed in the United States National collection of Coccidae. While a few specimens have become avail-

able in recent years, this situation was modified only during the summer of 1944, when specimens in numbers from an infestation of one species on timothy were sent in for examination from Wooster, Ohio, and when this same species was found on foxtail inside the city of Washington, D. C.

After reviewing the descriptions of the species that have been assigned here, it appears reasonably certain that this recently collected insect is undescribed, and since it has been reported from an important forage

¹ Received December 11, 1944.

plant, the name and description here presented may prove useful to economic entomology. At the same time a review of the other species assigned to the genus is attempted, although this, of necessity, is based mostly on literature and not on actual specimens of the species involved and so undoubtedly possesses the deficiencies of work so based. Through the much appreciated courtesy of Prof. G. F. Ferris, it has been possible to examine a specimen from the type material of the genotype, *Heterococcus arenae* Ferris, and supplementary descriptive notes and figures for this species, as well as a broadened generic diagnosis, thereby have been added to the paper. The illustrations accompanying the paper were drawn by Mrs. Sara Hoke DeBord.

GENERIC RELATIONSHIPS OF HETEROCOCCUS

There exists at present so much confusion respecting the characteristics and limits of the various genera that have been described among the mealybugs that any suggestions or conclusions that may be offered in this restricted study must be accepted as tentative or preliminary. Professor Ferris in his initial presentation of this genus stressed the combination of the characters 9-segmented antennae, tarsal claw with denticle, and presence of circular pores only in the dorsal derm as a basis for generic recognition. With some additions and elaboration these still seem to present the most significant characteristics of the group of species involved.

To anyone who has examined numbers of mealybugs, the outstanding characteristic of this genus surely will be the numerous circular multilocular disk pores, normally quinquelocular, that are distributed widely over both surfaces of the body and that appear obviously to represent an alternate to the small trilocular (and usually triangular) disk pores that may be called a normal feature of mealybug anatomy. These circular pores are so distinctive that they must have some classificatory significance, and on this account consideration has been given to certain other mealybugs that are known to possess them in comparable striking fashion. Possibly additional species in the mealybug group beyond those discussed should be considered, but many of the

specific descriptions are too incomplete to permit accurate recognition of their relationships.

First in line for consideration is one of the species originally described in the genus *Heterococcus*, *H. painei* Laing (15, p. 20). This species, while conforming with some elements of the original generic characterization, is described as lacking any definite indications of cerarii, such as the paired spines on the anal lobes of the genotype, and as possessing a single transverse ventral cicatrix (or circulus), a structure not found in any of the species here considered to belong properly in the genus. The stout oval body of *painei* and its very different habitat, on coconut in the South Pacific, also contribute to the conclusion that it would be best to exclude the species from *Heterococcus*. On the basis of present imperfect knowledge of mealybug generic standards, a new genus for this species would seem to be indicated and is described in this paper.

A second species in which the quinquelocular pores are numerous and conspicuous, and which possesses other characteristics of *Heterococcus*, as 9-segmented antennae, cerarian spines, and denticulate claw, is the one described as *Pseudococcus flagrans* by Brain (3, p. 140). Although it is so similar to *Heterococcus*, it became evident, in the process of checking literature, that *flagrans* is congeneric with and closely related to *Annulicoccus ugandensis* James (13, p. 209), having the same 9-segmented antennae, the same row of four ventral cicatrices down the ventral abdominal midline, and, from James's illustration, an even greater abundance of large quinquelocular and smaller multilocular disk pores. Surprisingly, however, while James in his generic discussion states flatly that the claw lacks a denticle, this, as indicated above, is definitely present, and sometimes almost conspicuous, in specimens of Brain's species. From examination of many species in the so-called *Phenacoccus* series of mealybug genera it has seemed that the presence of a claw denticle (usually in association with 9-segmented antennae) was positively significant as evidence of a segregation group including several genera. Even if the presence or absence of a claw denticle is actually without classificatory significance in *An-*

mulicoccus, the genus certainly seems to be a sound morphological and ecological segregate with the two species here associated in it.

The presence of more or less enlarged, circular, usually quinquelocular pores has been reported for several species of *Ripersia*, but, so far as has been ascertained, only one of these, *Ripersia asphodeli* Bodenheimer (1, p. 178) appears to approach *Heterococcus* in respect to the abundant development and very wide distribution of the quinquelocular pores. In this species, on the basis of specimens supplied by Dr. Joseph Carmin, the large quinqueloculars (many actually are quadrilocular, or sometimes even trilocular) are heavily distributed over the body, especially along the margin and towards the apex of the abdomen, there is a distinct claw denticle, apical cerarii are developed and no ventral cicatrix or circulus is present. To this extent the insect is very strongly suggestive of *Heterococcus*, but the antennae are reduced to six segments, a few normal, small trilocular, pores are present, chiefly in the developed cerarii, and there are none of the large multilocular disk pores which occur in most of the species of *Heterococcus*. The situation of this species seems to be comparable to that of *H. painei*, already discussed, in that its characteristics, on the basis of our present knowledge of mealybug generic standards, appear to entitle it to segregation in a distinct generic unit; certainly it stands out as sharply as *Brevennia* and *Lacombia* separated from *Ripersia* as subgenera by Goux (10).

Accordingly, it has seemed best, in spite of the fragmentary character of this study, to establish a new genus for this anomalous species.

These various genera, so far as our present knowledge goes, may be separated from all other described mealybugs by the presence in the derm, both dorsally and ventrally, of numerous, circular, usually quinquelocular (but the loculi may range from three to six or more) disk pores, these occupying the place of the characteristic small trilocular pores of most mealybugs, with the triloculars either wanting entirely or greatly restricted in numbers and distribution.

The key below is offered for the separation of the four genera under discussion.

Genus *Annulicoccus* James

Adult female.—Thinly coated with white secretion, without cerarian tassels, body color pinkish, size medium (length 2–4 mm), elongate elliptical, length more than twice width, wholly membranous. Antennae 9-segmented, as in *Heterococcus*. Eyes approaching hemispherical, with only a small asymmetrical sclerotized base. Legs a little thickened, an obscure pattern of widely scattered tiny pores more or less developed on femur and tibia, these lacking on coxa, claw with or without denticle, tarsal digitules slender, acute, attaining or exceeding claw apex, claw digitules slender, slightly knobbed apically, slightly exceeding the claw apex. Beak very short conical, incompletely 2-segmented. Spiracles not unusual, with both quinqueloculars and multiloculars associated with each. Dorsal ostioles developed, not conspicuous, lips with some pores and setae. Cerarii not sharply developed, superficially with only the apical two or three pairs obvious, these each with two (rarely one) lanceolate spines and numerous rather long and stout setae and quinquelocular-type pores associated; actually (at least in *flagrans*) with 16 or 17 pairs of cerarian structures, each, except posterior as stated,

KEY TO HETEROCOCCUS AND ASSOCIATED GENERA

- a. One or more ventral cicatrices present.
 - b. A single transverse ventral cicatrix; no traces of cerarii, not even one or a pair of slender spines in any cerarian area; multilocular disk pores few, restricted to midventral areas of last three segments. *Laingiococcus*, n. gen.
 - bb. Four conspicuous, circular to transversely elliptical ventral cicatrices in a row down ventral midline of abdomen; definitely recognizable cerarian spines present, on anal lobes at least; multilocular disk pores much more abundant, in wide bands on ventral surface of posterior abdominal segments and in irregular rows dorsally; quinquelocular-type pores distinctly larger than multiloculars. *Annulicoccus* James
- aa. No ventral cicatrices present.
 - c. Antennae normally 9-segmented; no trilocular (triangular) pores present; multiloculars usually present, lacking in one species. *Heterococcus* Ferris
 - cc. Antennae 6-segmented; a few trilocular pores present in cerarii and widely scattered elsewhere; multiloculars lacking. *Asphodelococcus*, n. gen.

with a single slender, lanceolate spine and several setae and quinquelocular-type pores. Anal lobes not developed, at most a faint bulge, no ventral thickening or any sclerotized area. Anal ring approaching the normal pseudococcine type, but the outer pores definitely circular in shape, loosely arranged in middle of row, bunched at ends, pores of inner row more tightly bunched throughout, this row shorter than outer; with six setae, the longest a little shorter than apical anal lobe seta. Four types of derm pores present, all in numbers: Large quinquelocular-type with range of four to six or even nine loculi, multiloculars, here smaller than the quinquelocular-type, much smaller short tubulars, expanded at inner ends, and finally very tiny, short, cylindrical, simple pores; no normal triloculars and no normal elongate, slender tubulars. Body setae numerous on both surfaces, varying strongly in size, stiff basally but tapering to delicate tips. Characteristically four circular to transversely stout elliptical ventral cicatrices, posterior smallest, located on the midline seemingly in the interspaces between the second to sixth segments.

Type of genus.—*Annulicoccus ugandensis* James (13, p. 209).

The preceding description has been based, in part, on specimens of the second species included, that is, *flagrans* (Brain), since the description of *ugandensis* omits mention of a few of the characters considered.

The two species now included may be separated by the following key:

- a. Claw without denticle; large quinquelocular-type pore described as actually with 6 to 9 loculi. *ugandensis* James
- aa. Claw with distinct denticle; quinquelocular-type pore actually normally with 5 loculi. *flagrans* (Brain)

The preceding discussion and the accompanying illustrations (Figs. 6, 14–21) of *flagrans*, drawn from specimens from Brain's type material, should serve not only to fix the generic characters clearly but also to present descriptive details beyond those provided by Brain in his original description of this species (3, pp. 140–143).

Asphodelococcus, n. gen.

Adult female.—Secretionary covering uncertain, body color pink, size medium, length around 3 mm, elliptical, wholly membranous. Antennae 6-segmented, apical segment much longer than any other and with four sensory

setae. Eye somewhat rounded and on a flat, asymmetrical, basal collar. Legs normal but small and a little thickened, posterior without pores on coxa or femur, a few scattered on tibia, claw denticle distinct, tarsal digitules acute, not exceeding claw apex, claw digitules faintly knobbed apically, surpassing claw apex. Beak stout conical, wider than long, incompletely 2-segmented. Spiracles not unusual. Both pairs of dorsal ostioles present. Only the posterior two or perhaps three pairs of cerarii plainly developed and recognizable, but others along the body margin vaguely indicated, developed cerarii including slender spines, trilocular pores, and spinelike accessory setae, smaller than spines, but otherwise hardly differentiated. Anal lobes indicated by rounded bulges, no ventral thickening, apical setae of moderate length. Anal ring approaching normal pseudococcine type, with two rows of pores on each half, and with six setae, the longest a little shorter than apical seta. Three types of pores present, normal small triloculars scattered in small numbers, large quinquelocular-type, with three to six loculi, very numerous and crowded, and small tubular ducts with inner ends thickened and swollen and externally protruding openings; no multiloculars. Dorsal body setae small, almost spinelike, scattered, inconspicuous in midst of pores, ventral considerably longer and more slender, but few and likewise inconspicuous. No ventral cicatrix.

Type of genus.—*Ripersia asphodeli* Bodenheimer (1, p. 178).

This is the only species at present known to possess any close approximation to the above combination of structural characters. From literature, *Lacombia* Goux (10, p. 62), based on the species *Ripersia bouhelieri* Goux (9, p. 199), possesses certain characteristics indicating possible relationship, since it lacks multilocular disk pores, but does have triloculars, quinqueloculars, and tubular ducts with protruding openings. However, there is no evidence from the description that the quinqueloculars occur in abundance as with this genus, the apical antennal segment is not so conspicuously elongated, there is no claw denticle, the body setae are comparatively very numerous, the anal ring is unusual, with the pores in the bands reduced in size and mostly widely separated, no cerarii are developed, and at least one ventral cicatrix is present. Certainly it is preferable to let these two stand as independent generic units until

much more knowledge on mealybug classification has accumulated.

The following descriptive details on the species *asphodeli* are supplementary to those given above in the generic description, and both should be used together for specific recognition.

***Asphodelococcus asphodeli* (Bodenheimer)**

Fig. 1-5, 7-13

Adult female.—As mounted, elongate elliptical, maximum observed length 3.25 mm, width 1.6 mm. Antennal segments in microns: I, 40-44; II, 36-40; III, 44-48; IV, 18-20; V, 23-24; VI, 64-70 (four antennae); preapical segment with a single long, slender, somewhat curved sensory seta in addition to the four similar ones on the apical segment. Lengths of parts of a posterior leg in microns: Trochanter, 52; femur, 112; tibia, 100; tarsus, 68; claw, 17; tarsal digitules, 20; claw digitules, 20; a few large indistinct areolae on coxa, pores on tibia 12-16; small, widely scattered; leg setae small, stiff. Observed beak dimensions: Length 62-72 μ , width 76-80 μ , with proportions maintained. Spiracles stout, but not enlarged, the bar with wide sclerotized extensions; posterior a little larger than anterior; a definite pore cluster around the opening of each spiracle, including 2-5 small trilobular immediately adjacent to outer margin of opening and a much larger number (25-50) of quinquelocular-type pores around three sides. Each dorsal ostiole centered in a roughly circular dermal area, of considerable size, free of the large quinquelocular-type pores; pore and setal association with the individual lips variable, from one tiny trilobular pore to as many as six, and from usually no setae to an observed maximum of two small, stiff ones. Only the two posterior pairs of cerarii sharply defined, each comprising two slender, faintly lanceolate spines about 19 μ

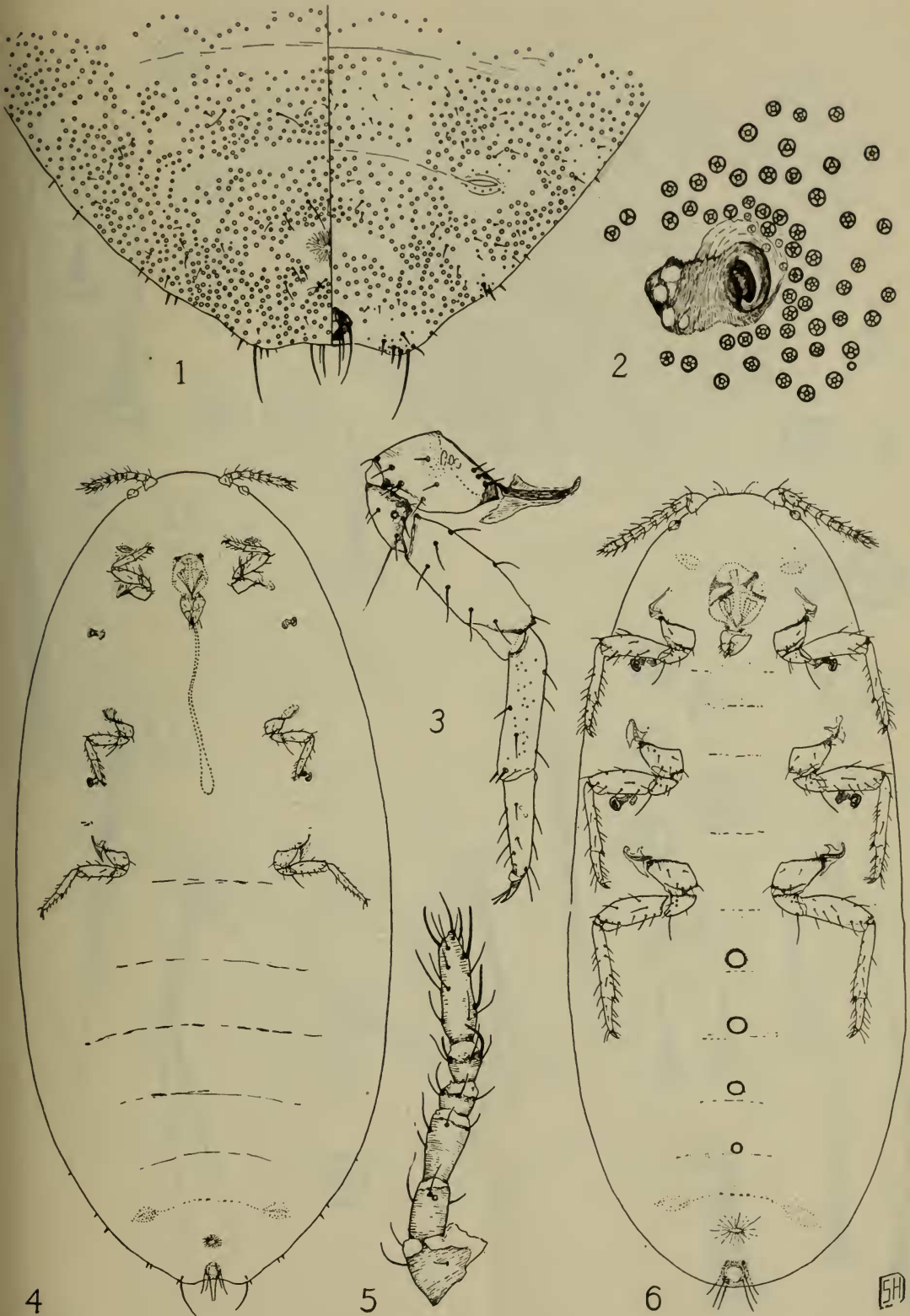
long, perhaps 12-15 (apical) or 6 to 10 (penultimate) small trilobulars and around five short, stiff setae of varying sizes, some hardly distinguishable from the paired spines, all loosely grouped in a marginal area of appreciable size devoid of the large quinquelocular-type pores; other abdominal segments with suggestions of cerarian development involving similar rather distinct cleared areas and one to several small spines or setae plus a few small trilobulars; parallel obscure hints at cerarian development anteriorly, but here intermingled directly with the large quinquelocular-type pores, not in cleared areas. With a very small, irregular, sclerotized area around the bases of the cerarian spines of the anal lobe, apical seta about 120 μ long, ventral subapical about 42 μ . Anal ring small, the pores in the outer row approximately circular, separated by interspaces except at ends; pores in inner rows irregular in shape, crowded; longest and ring seta about 105 μ . Trilobular pores around 3.5 μ in diameter, quinqueloculars around 7 μ , internal length of tubular ducts about the same, these with a short, cylindrical, external collar and a considerably longer membranous, somewhat tapering extension, together approximating a little more than half the internal length of the duct. The few scattered dorsal setae with an observed length range of 9-16 μ , the longer ventral setae ranging up to 43 μ .

This redescription is based on mounted examples of the species, collected by Dr. Joseph Carmin at Tel-Aviv, Palestine, April 12, 1927, prior to the date of publication of the original description of the species. Examiners of both this and the original description will find some discrepancies between the two, notably in the measurements of the antennal segments; all such divergences have been rechecked on the material studied, and statements here presented are believed accurate for this material.

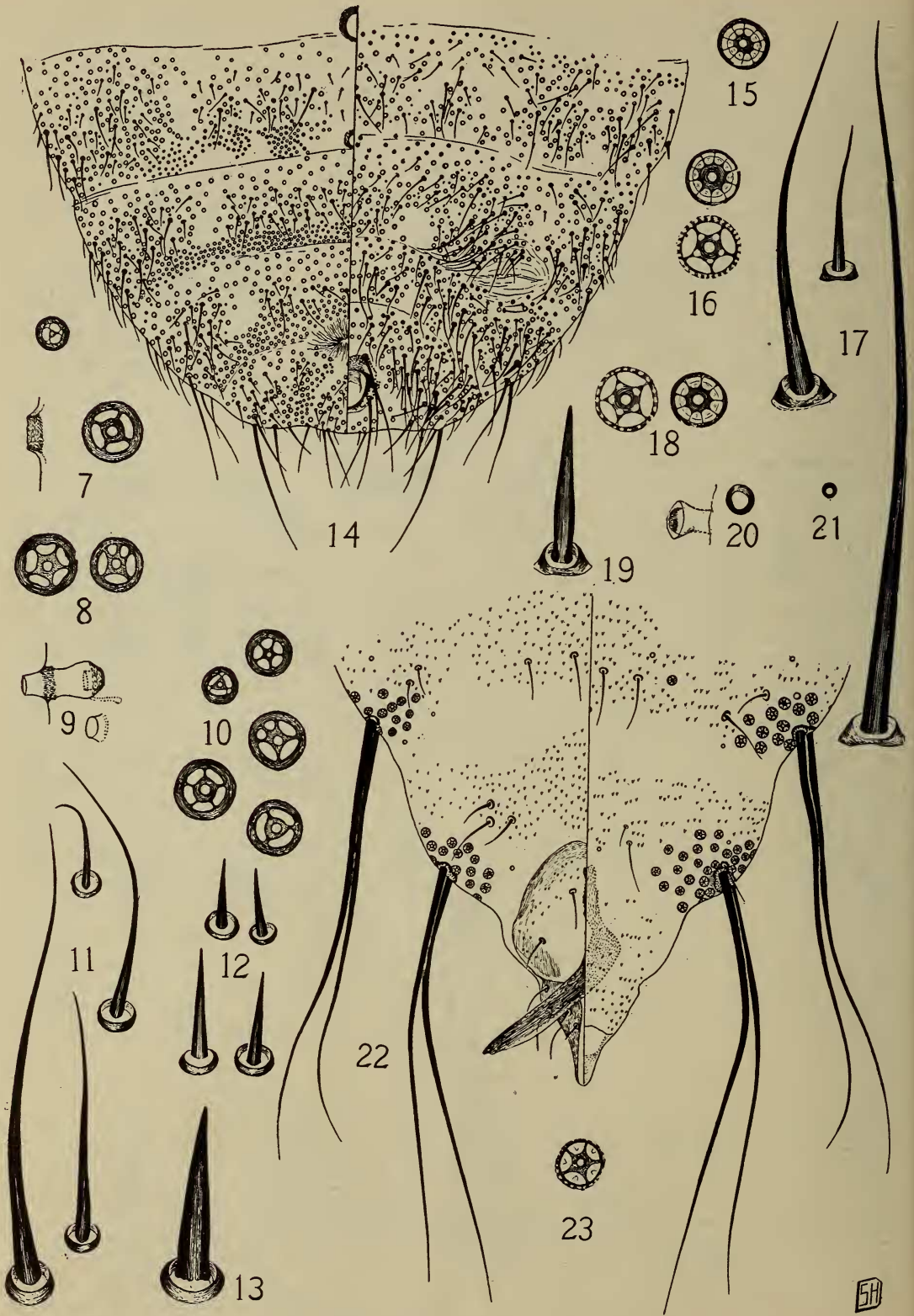
Figs. 1-5, 7-13.—*Asphodelococcus asphodeli*, adult female: 1, Apex of abdomen, dorsal and ventral, $\times 115$; 2, posterior spiracle with associated pores, $\times 460$; 3, posterior leg, $\times 230$; 4, body, optical section, $\times 50$; 5, antenna, $\times 230$; 7, disk pores in spiracular area, $\times 1,500$; 8, ventral disk pores, $\times 1,500$; 9, tubular duct, $\times 1,500$; 10, dorsal disk pores, $\times 1,500$; 11, ventral setae, showing size variation, $\times 1,500$; 12, dorsal setae, $\times 1,500$; 13, single cerarian spine, $\times 1,500$.

Figs. 6, 14-21.—*Annulicoccus flagrans*, adult female: 6, Body, optical section, $\times 50$; 14, apex of abdomen, dorsal and ventral, $\times 115$; 15, multilobular disk pore from spiracular area, $\times 1,500$; 16, ventral multilobular and quinquelocular disk pores, $\times 1,500$; 17, body setae, $\times 1,500$; 18, dorsal multilobular and quinquelocular disk pores, $\times 1,500$; 19, cerarian spine, $\times 1,500$; 20, tubular duct, $\times 1,500$; 21, minute simple pore, $\times 1,500$.

Figs. 22, 23.—*Heterococcus graminicola*, adult male: 22, Apex of abdomen, dorsal and ventral, $\times 650$; 23, disk pore from cerarius of same, $\times 1,500$.



Figs. 1-6.—(See opposite page for explanation.)



Figs. 7-23.—(See p. 42 for explanation.)

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Genus *Heterococcus* Ferris

Adult female.—Occurring on Gramineae, beneath leaf sheaths, accompanied by more or less white secretion and thinly coated with white powder. Size medium (length 1.5–3 mm), varying strikingly according to maturity of the individual; elongate elliptical to almost parallel-sided, length usually more than twice width. Membranous throughout. Antennae characteristically 9-segmented, the joint between eighth and ninth rigid and often incomplete or lacking; one slender sensory seta on seventh, one on eighth, three on ninth. Eyes circular in outline, approaching hemispherical, each on a small asymmetrical base. Legs normal, a little thickened, no pores on hind coxae, but tiny ones scattered on hind femora and tibiae; claw denticle developed; tarsal digitules slender, acute, not exceeding claw apex, claw digitules slender, slightly knobbed apically, definitely exceeding claw apex. Beak short conical, incompletely 2-segmented. Both pairs of dorsal ostioles present, the lips more or less ornamented with quinquelocular pores and small setae. Definitely recognizable cerarian development at most restricted to the posterior two to four pairs, and the cerarii, even here, not sharply defined, the association of the two

spines, quinquelocular pores, and spinelike setae loose and sometimes even indistinct; existence in some species of additional cerarii on anterior abdominal segments and especially on head above eyes more or less suggested but not clearly evident. Anal lobes at most rounded bulges, apical seta definitely developed on each, no ventral thickening. Anal ring of normal pseudococcine type, with six setae, the longest a little shorter than apical seta, and inner and outer rows of pores on each half. Several pore types developed among included species though not all present on each, these including quinquelocular disk, large multilocular disk, tiny clear circular disk, and slender tubular duct. Dorsal body setae small, inconspicuous, varying from slender to almost spinelike; ventral setae slender, averaging much longer, all varying much in size. No ventral cicatrix.

Type of genus.—*Heterococcus arenae* Ferris (4, p. 65).

Although no attempt is made at this time to provide generic descriptions for stages other than the adult female, since these are known from only a single species, the descriptions of the first-stage larva and adult male that are presented for the new species described later from timothy and other hosts should supply

KEY TO SPECIES OF HETEROCOCCUS

- a. Multilocular disk pores wanting; cerarii not developed, cerarian spines represented only by slender setae. *biporus* (Goux)
- aa. Multilocular disk pores present; at least the apical cerarii developed and usually with evidence of others.
 - b. Posterior cerarian spines tiny, perhaps one-sixth length of longest of 4 or 5 slender accessory setae associated in each cerarius. *nudus* (Green)
 - bb. Posterior cerarian spines much larger, at least half length of longest of associated accessory setae.
 - c. Cerarian spines and dorsal derm setae slender (see figures), tapering, at most only very faintly lanceolate; multilocular disk pores relatively few, restricted to vulvar area of ventral surface. *arenae* Ferris
 - cc. Cerarian spines and dorsal derm setae with obviously stouter proportions, definitely slender spinelike, often fairly distinctly lanceolate; multilocular disk pores much more numerous, present all along body margin and on both surfaces of the abdomen.
 - d. Multilocular disk pores more numerous in midabdominal area, dorsally fourth to seventh segments inclusive each with two rows, one complete and one interrupted medially, ventrally with a broken transverse row on third segment, an entire row on fourth, a band three pores wide on fifth, and numerous pores across sixth and seventh [*tritici* Kiritshenko of Borkhsenius]. *borkhsenii*, n. sp.
 - dd. Multilocular disk pores, while variable, fewer in midabdominal area, thus, dorsally fourth to seventh segments inclusive each with a single, often somewhat irregular and often incomplete row of pores, ventrally one or two pores on third, several on fourth in a medially interrupted single row, around 20 on fifth in a more narrowly interrupted single row, a continuous band two or three pores wide on sixth, a similar band on seventh, and numerous pores on eighth.
 - e. Anal lobe apical and anal ring setae normal, slender, long-tapering, lobe seta around 150 μ , longest anal ring seta around 96 μ *graminicola*, n. sp.
 - ee. Anal lobe apical and anal ring setae heavy, short, often bifurcate apically, lobe seta 68 μ or less, anal ring setae less than 50 μ *occidentalis*, n. sp.

reasonably satisfactory evidence as to the structural characteristics to be expected for these stages in all the included species.

Thus far, five species have been described in or have been transferred to this genus. One of these, *painei* Laing, is made the type of a new genus in this paper. The remainder, together with two apparently undescribed species, are discussed below. All these have been reported from grasses (Gramineae) only.

Goux (8, p. 253), in connection with his description of the new species *biporus*, reduces *Heterococcus* Ferris to the status of a subgenus of *Phenacoccus* Cockerell, but from the present and other studies of mealybug classification it appears that the basic framework of a classification in the group is so poorly developed that there is little assurance that such a subordinate relationship presents a true picture. Accordingly *Heterococcus* Ferris is re-accepted in its original standing as a genus.

The foregoing key is offered for the separation of the species here included in the genus. No specimens of any of the three European species have been available for examination.

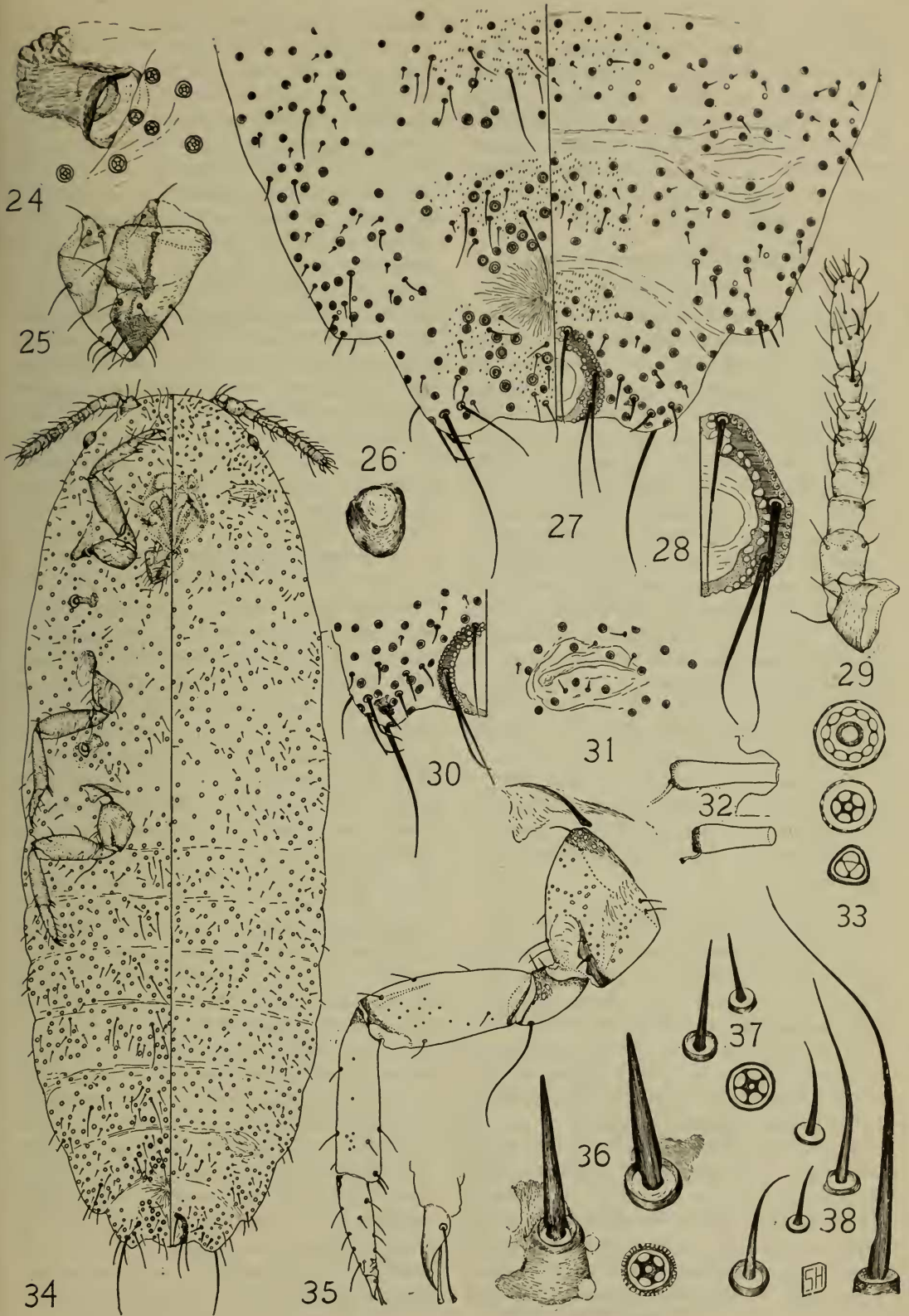
Heterococcus arenae Ferris

Figs. 24-38

Adult female.—Elongate, sides nearly parallel, length 1.6 mm, width 0.55 mm, rounded tapering at anterior end, tapering posteriorly past the penultimate segment, then sharply constricted to the protruding anal segment. Membranous throughout. Antennae normally 9-segmented, maximum longitudinal dimensions of the segments in microns as follows: I, 32-36; II, 40; III, 28-32; IV, 20-22; V, 20; VI, 18-20; VII, 24; VIII, 24-26; IX, 35-38; last two segments incompletely separated in one antenna, combined length 60; sensory setae slender, curved, about 20 μ long. Eye small, rounded, set on a comparatively large base, eye diameter about 16 μ , base about 33 μ . Posterior leg maximum longitudinal dimensions in microns: Trochanter, 60; femur, 120; tibia, 116; tarsus, 68; claw, 20; tarsal digitules, 20; claw digitules, 18-20; claw denticle sometimes ob-

scure; pores on leg parts somewhat uncertain from specimen available, presented in figure as believed to occur. Beak somewhat distorted, apparent dimensions: Length 60 μ , width 72 μ . Bar of spiracle rather broadly sclerotized, a few scattered pores adjacent to opening. Lips of dorsal ostioles each with two to four quinqueloculars and posterior lip of anterior ostiole with two to three small setae in addition. Each apical cerarius recognizable as a combination of two slender spines about 18 μ long, with a quinquelocular pore between them, and with a tiny, irregular, sclerotized area at base of one or more spines, and of a loose group of six to nine additional quinqueloculars and four to five stiff setae, hardly differentiated from the spines and 9-38 μ long; the penultimate cerarian association is recognizable as two slender, well-separated spines, each being about 18 μ long with a slightly closer association of the quinqueloculars around them; spines of other anterior cerarii probably present, but not clearly distinguishable through size, shape, or pore association. Anal lobes somewhat developed, rounded (the specimen probably recently molted), apical seta around 112 μ long, subapical ventral 35-56 μ ; no ventral thickening. Anal ring with longest setae about 84 μ . Body with numerous quinquelocular pores with average diameter about 5 μ , but varying somewhat, these approximately uniformly distributed both dorsally and ventrally, except on the intersegmental lines; a few multiloculars, each usually with 10 loculi and average diameter about 6.6 μ , on the underside of the abdomen, as follows in specimen examined: 16 behind vulvar opening, 17 in a loose cluster just anterior to vulvar opening, 4 on the next segment anterior; with a few slender, delicate tubular ducts about 10-11 μ long, and somewhat varying in diameter, distributed over the body on both surfaces, some, at least, with opening on a protruding cone. Body setae small and inconspicuous dorsally, stiff but not spinelike, lengths from 4-12 μ in middorsal area; ventrally much larger and more slender, lengths from 7-55 μ in midventral area.

FIGS. 24-38.—*Heterococcus arenae*, adult female: 24, Posterior spiracle, $\times 460$; 25, beak, $\times 330$; 26, eye and tubercle, $\times 370$; 27, apex of abdomen, dorsal and ventral, $\times 230$; 28, anal ring, detail of right half, $\times 460$; 29, antenna, $\times 230$; 30, dorsal aspect of left anal lobe area, $\times 230$; 31, anterior dorsal ostiole, $\times 230$; 32, tubular ducts, one with protruding opening, $\times 1,500$; 33, ventral disk pores, multilocular, normal quinquelocular and abnormal quinquelocular, $\times 1,500$; 34, body, dorsal and ventral, showing pore distribution, $\times 87.5$; 35, posterior leg, $\times 230$, with detail of claw, $\times 650$; 36, detail of cerarian spines, $\times 1,500$; 37, dorsal setae and disk pore, $\times 1,500$; 38, ventral body setae, $\times 1,500$.



FIGS. 24-38.—(See opposite page for explanation.)

This species has been redescribed from a single adult female, evidently recently molted, from the type material labeled as collected from *Poa douglasii* on dunes near Pacific Grove, Calif., December 1, 1917, by G. F. Ferris. In addition to this record, Ferris again collected the species, on an undetermined perennial grass, in Inyo County, Calif., between Big Pine and Deep Springs (5, p. 22).

Heterococcus biporus (Goux)

Judged from Goux's description (8, p. 253), this species differs more widely from the characteristic generic condition than does any other included, since it lacks the multilocular disk pores that appear in all the others, the tubular ducts are described as restricted to the ventral surface, and cerarii are reported to be undeveloped, though possibly represented by a pair of long setae on each margin of each of the last two abdominal segments. In his discussion of its relationships the author suggests that it would be desirable to erect a new subgenus of *Phenacoccus* for his species if it were established that the type of Ferris's genus possessed multilocular disk pores. However, from this study of available specimens and descriptions it has seemed best to retain the species in *Heterococcus*, although possibly a different conclusion might have been reached if actual specimens of *biporus* had been studied.

The insect was collected in July 1934 at Tamaris, in the Var Department of France, on *Brachypodium pinnatum*, and there appears to have been no subsequent published record of its rediscovery.

Heterococcus borkhsenii, n. sp.

In 1932 Kiritschenko (14, p. 135) (as Alexis Kiricenکو) described the species *Trionymus tritici* from the vicinity of Odessa, U.S.S.R., reporting among other descriptive items body dimensions of 8–9 mm by 3 mm, and the color as pale pink. Later, in 1937, Borkhsenius (2, p. 55), in his tables for the identification of coccids (Coccidae) injurious to cultivated plants and forests in the U.S.S.R., transferred this species to the genus *Heterococcus* and presented a short description and figure for it. On the basis of a noncritical translation of this portion of his paper, which appeared only in Russian, the conclusion appears unavoidable that the specimens which he discusses represent a different species from that described by Kiritschenko. As

partial evidence it may be noted that the Borkhsenius specimens have reported dimensions of 2 mm by 1 mm, instead of 8–9 mm by 3 mm, and that the body color is yellowish, not pinkish. Discrepancies in other parts of the descriptions, though less striking, are likewise evident. So far as the literature has been examined no other name seems applicable to the material reported by Borkhsenius and it is therefore here called *borkhsenii*, n. sp., on the basis of his description and figure (2, p. 55). This insect evidently is extremely closely related to the first of the new species described below, and, indeed, it has been difficult to find in Borkhsenius's brief description a positive basis for the separation of the two, yet without some tangible evidence of actual interchange, or, at least, opportunity for this, it does not seem desirable to assume that our American specimens are identical with the Russian species which Borkhsenius discussed.

Heterococcus graminicola, n. sp.

Figs. 22, 23, 39–49, 51–61

Adult female.—Developing between the leaf sheaths and stems of the host, producing some white waxy secretion, and lightly coated with white secretion. Color a pale yellow. Body, as mounted, at least twice as wide as long, varying considerably in size, from a minimum of 1.41 mm by 0.53 mm in recently molted adults to an observed maximum of 3.25 mm long by 1.6 mm wide in fully distended individuals. Maximum dimensions in microns of segments of one, apparently average, antenna as follows: I, 36; II, 40; III, 32; IV, 21; V, 25; VI, 22; VII, 30; VIII, 37; IX, 44; however, obviously with much variation in the lengths of all segments; the sensory setae on apical segments slender, curved, showing an observed length range of 28–44 μ ; each intermediate antennal segment with a minimum of four to five setae. Eye base about 36 μ long, 24 μ wide, and, with eye itself, perhaps 12 μ high, but variable. Posterior leg with maximum dimensions in microns of parts measured: Trochanter, 73; femur, 170; tibia, 163; tarsus, 85; claw, 20; tarsal digitules, 24; claw digitules, 26; claw denticle usually quite distinct; as with the antennae, considerable variation in the dimensions of the parts of the posterior leg apparent in different individuals; a pattern of scattered, tiny, clear pores over the upper surface of femur and tibia, but none on coxa. Beak around 73 μ long by 76 μ wide, but

dimensions varying somewhat. Dorsal ostioles inconspicuous, especially on distended specimens, usually three to four quinqueloculars on each lip, and a single short, stiff seta on the posterior lip of each cephalic ostiole. The posterior three pairs of cerarii fairly plainly developed, and the fourth and fifth from the caudal apex often suggested by a pair of recognizable cerarian spines, the two spines in each pair usually distinctly separated, but appreciable variation occurring in the extent of development of all these cerarii; an average anal lobe cerarius including two faintly lanceolate spines around 17–22 μ long, about 15–18 loosely grouped quinquelocular pores, and 3–6 stiff, short setae, differentiated from spines chiefly by smaller size; basic organization of the other evident cerarii including two spines and a few quinqueloculars, with the small setae really outside this association; a recognizable supraocular cerarius including, usually, three small spines and two or more quinqueloculars; organization of all cerarii, except anal lobe pair, tending to become obscured with body distension at maturity. Anal lobes suggested by rounded bulges in just molted adults, not evident in fully distended individuals; apical seta with maximum observed length 157 μ , ventral subapical 60 μ , and several smaller ventral setae from 16 μ to 32 μ long. Longest observed anal ring seta 100 μ . Derm pores and ducts numerous, quinqueloculars widely and fairly uniformly distributed over both surfaces except for intersegmental clear bands and areas occupied by multiloculars, diameter around 4 μ ; multiloculars with diameter around 6–7 μ and 10–12 loculi distributed in groups or rows dorsally, ventrally, and along margin, these groups conspicuous only in recently emerged adults, more or less obscured in fully distended individuals; numbers and groupings varying much from individual to individual, approximately as follows in one examined fully: Along margin, each side a cephalic group of 25 before antennal base, an ocular group of 5 or 6, a postocular of 17, about 5 scattered, a group opposite anterior coxa of 11, 2 scattered, a group opposite midcoxa of 8, 4 scattered, a group opposite posterior coxa of 7, first abdominal 6, second abdominal 3, third abdominal 12, fourth abdominal 15, fifth abdominal 20, sixth abdominal 36, seventh abdominal 46, last two practically continuous with ventral transverse rows of similar pores; dorsally with

a scattered transverse row of 10 pores on abdominal segment III, of 17 on abdominal segment IV, of 20 on V, of 15 on VI, of 5 on VII; ventrally with 1 on III, 9 on IV, interrupted medially, 31 on V, 44 on VI, about 70 on VII, and about 65 on VIII; slender tubular ducts numerous ventrally, in one individual around 16 on underside of each anal lobe, around 66 across abdominal segment VII (prevulvar), around 98 across the next preceding (VI), around 71 on the next (V), and successively fewer on the anterior abdominal segments; apparently wholly absent on head and thoracic segments, much fewer dorsally on abdominal segments and likewise apparently absent on head and thorax, approximate length 9–10 μ , diameter at opening 1.7 μ , at inner end 2.1 μ ; a very few tiny, flat, cylindrical pores without apparent internal structure, with diameter about 1.6 μ visible both dorsally and ventrally. Dorsal setae not numerous, small and inconspicuous, stiff, almost spinelike, observed lengths varying from 3–6 μ in the middorsal area, to 10 μ toward margins; ventral setae slender, much longer, 12–36 μ in midventral area and up to 44 μ toward apex of abdomen.

Larva.—Elongate ovoid, length 0.52 mm, width 0.2 mm. Body membranous throughout, except a small, slender thickening from base of ventral subapical seta of each anal lobe. Antennae not unusual, dimensions of one in microns; I, 20; II, 20; III, 16; IV, 10; V, 12; VI, 56; three long sensory setae at apex of terminal segment, one on preapical. Eyes distinct, somewhat bulging, anterior margin of small, basal collar much wider than posterior. Legs not unusual, maximum lengths, in microns of parts of a posterior one: Trochanter, 32; femur, 64; tibia, 52; tarsus, 56; claw, 18; acute tarsal digitules, 24, faintly knobbed, slightly dissimilar, claw digitules, 18; claw denticle weakly developed but usually evident, sometimes obscure or wanting. Beak short conical, rounded apically, 40 μ long by 44 μ wide, incompletely 2-segmented. Spiracles small circles with slender tapering bar, a single quinquelocular pore outside each. Dorsal ostioles present, but obscure, especially the anterior. No complete cerarii developed, but a pair of enlarged spines on each side of anal ring, and additional pairs, reduced in size and the two spines more or less obviously associated, along the body margin to the cephalic apex, a total of 18 pairs evident and possibly homologous with the true cerarian

spines of species having these fully developed; individual quinquelocular pores more or less obviously associated with each spine pair. Anal lobes not developed, only a slight bulge on each side of anal ring; apical seta 76μ , ventral subapical 28μ , a small, irregular thickening about twice as long as wide extending forward from this. Anal ring normal, with 6 setae with maximum length around 40μ . Only quinquelocular-type pores present, appearing as if in longitudinal rows on abdomen, middorsal about 2.4μ in diameter, laterals up to 4μ . Setae tiny, almost spinelike, about 4μ in middorsal area, somewhat larger laterally and posteriorly, with anal lobe cerarian spines about 8μ ; ventral setae slender, maximum about 20μ .

Adult male.—Fully developed, winged, thorax strongly sclerotized; body length (of one individual) 1 mm, width (through thorax) 0.26 mm. Head rounded from above, ventral surface more strongly sclerotized, this sclerotization continued dorsally on each side into an elongate triangular area enclosing the two upper eyes. Front of head, around and between antennae, and middorsal area between eyes somewhat less strongly sclerotized, bearing an irregularly elongate cluster of 10–12 tiny, simple pores above each antennal insertion, an irregular row of around 10 curved setae, each about 13μ , on each side between upper eye and mid-line, and perhaps 15 longer curved setae, up to 22μ , between antennal insertion and lower eyes; posterior portion of head membranous, transparent, bearing a cluster of 4–5 small setae (around 14μ) dorsally on each side behind sclerotized area enclosing upper eye. Prothorax strongly transverse, anterior margin, and a triangular, posteriorly directed extension of this on each side, an irregular plate at posterior margin behind the anterior marginal areas, and coxal attachment piece all sclerotized; remainder of prothorax membranous; quinquelocular disk pores and small setae dorsally as in figure,

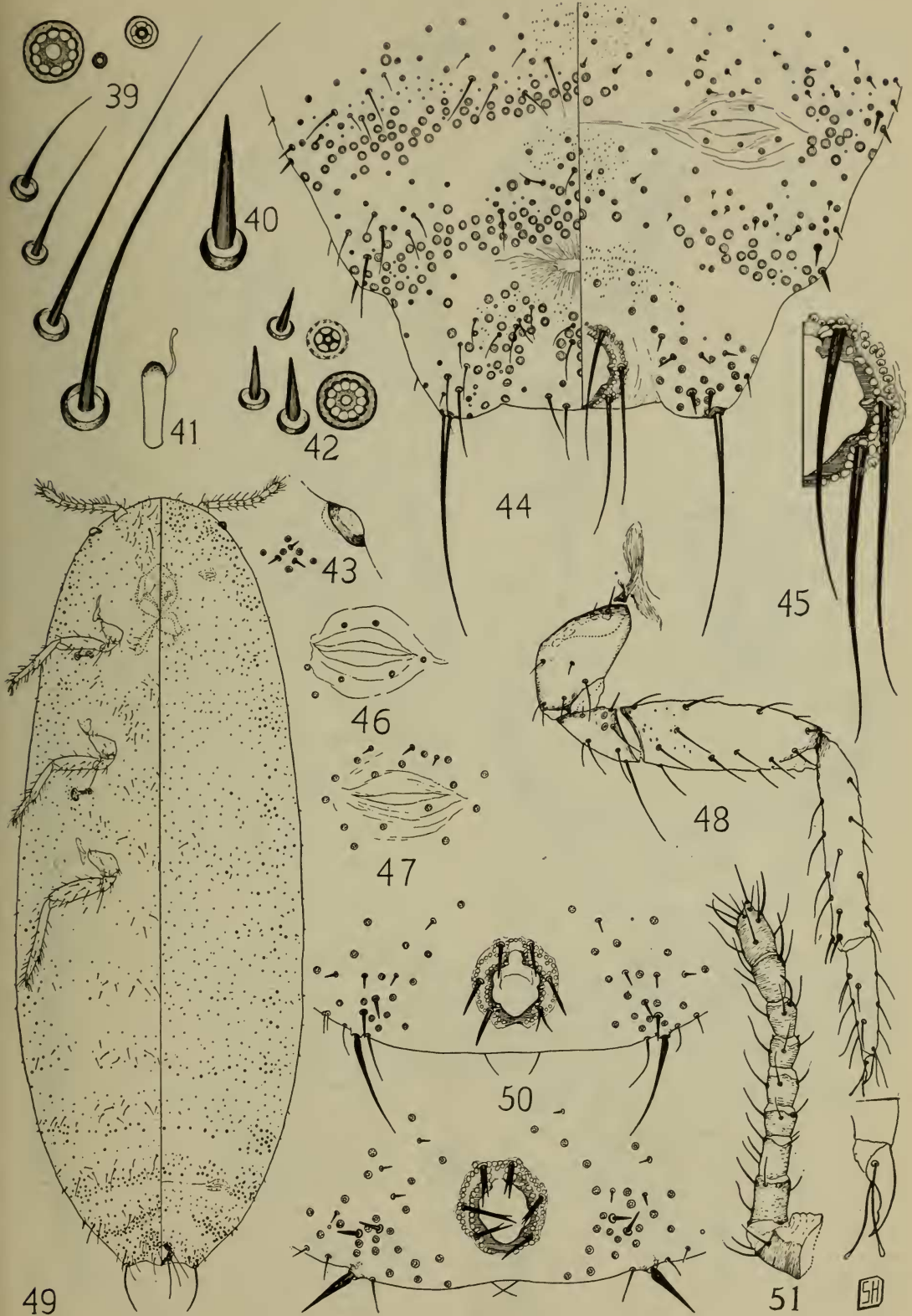
a pair of quinqueloculars and two tiny simple pores between coxae, and a pair of setae with a tiny simple pore behind each coxa ventrally. Mesothorax and metathorax definitely sclerotized, shape and dorsal setae as shown in figure, length 280μ , width 260μ ; wing shape and venation as in figure, surface thickly clothed with tiny hairs, with larger ones forming a marginal fringe, length 800μ ; halteres about 60μ long, elongate, somewhat enlarged about middle but with anterior margin irregular and incised at one or more points; a single apical seta, strongly recurved, at apex, length to apex of curve 48μ . Legs moderately slender, each trochanter with three sensory pores on each face, each tarsus plainly 2-segmented, the basal ringlike, claw nearly straight, with small denticle on inner face about one-third of length from tip; leg setae stiff, but tapering to very slender apices, a pair of definitely enlarged, spinelike setae at apex of each tibia; lengths of parts of a hind leg in microns: Trochanter, 48; femur, 120; tibia, 162; tarsus, 84; claw, 27; slender tarsal digitules, 32; short, acute claw digitules, 5. Abdomen membranous throughout, except for apex and for one complete transverse sclerotized band just behind scutellum and one to three additional, medially interrupted and obscure, on the one to three segments immediately following that bearing the complete band; arrangement of dorsal quinquelocular and tiny disk pores and setae (about 22μ) about as shown in figures; ventrally with a transverse row of from four to eight setae (about 16μ) across the mid-line of the segments, and with a marginal cluster, characteristically of three to four setae, a single quinquelocular and a single tiny disk at each margin of the segments anterior to the cerarii; two pairs of cerarii, each cerarius with two long (156μ), slender setae, a close cluster of quinquelocular pores (anterior around 24, posterior around 46), two to four tiny disk pores, and usually just outside the pore cluster

FIGS. 39–49, 51, 54.—*Heterococcus graminicola*, adult female: 39, Ventral setae and disk pores, $\times 1,500$; 40, cerarian spine, $\times 1,500$; 41, tubular duct, $\times 1,500$; 42, dorsal setae and disk pores, $\times 1,500$; 43, eye and adjacent supraocular cerarius, $\times 370$; 44, apex of abdomen, dorsal and ventral, $\times 230$; 45, anal ring, right half, $\times 460$; 46, anterior and 47, posterior dorsal ostioles, $\times 230$; 48, posterior leg, $\times 230$, with detail of claw, $\times 650$; 49, body, dorsal and ventral, with distribution of pores, $\times 50$; 51, antenna, $\times 230$; 54, beak, $\times 330$.

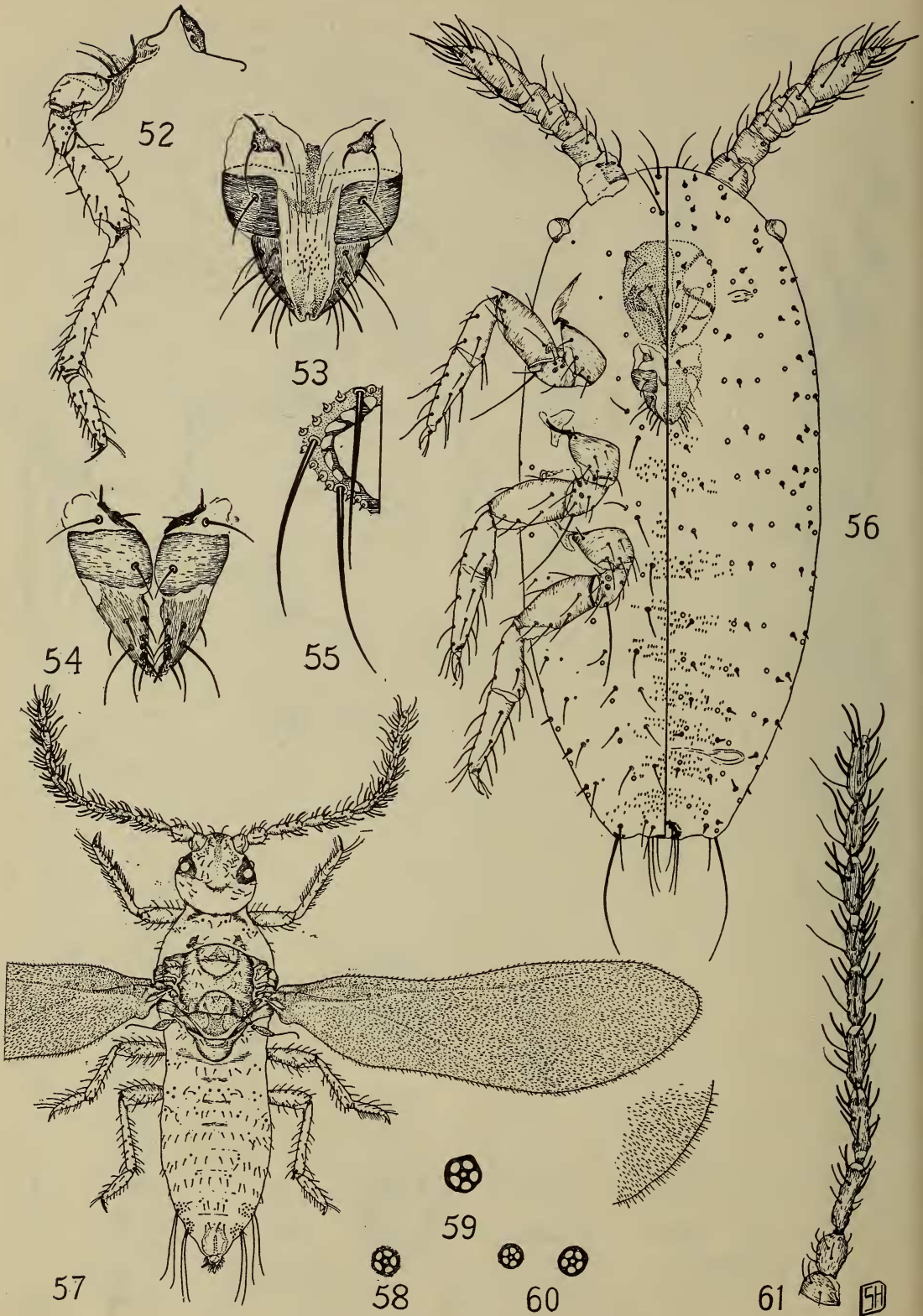
FIG. 50.—*Heterococcus occidentalis*, adult female, apices of abdomen, dorsal of two individuals, $\times 230$.

FIGS. 52, 57–61.—*Heterococcus graminicola*, adult male: 52, Posterior leg, attachment plate and halter, $\times 165$; 57, body, dorsal, $\times 87.5$, with detail of wing margin, $\times 165$; 58, ventral disk pore, $\times 1,500$; 59, marginal disk pore, $\times 1,500$; 60, dorsal disk pores, $\times 1,500$; 61, antenna, $\times 165$.

FIGS. 53, 55, 56.—*Heterococcus graminicola*, first stage larva: 53, Beak, $\times 650$; 55, anal ring, left half, $\times 825$; 56, body, dorsal and ventral, $\times 230$.



Figs. 39-51.—(See opposite page for explanation.)



Figs. 52-61.—(See p. 50 for explanation.)

two to five slender setae; genital capsule at apex of abdomen about 100μ long, its protruding tip with expanded conical base about 36μ ; penis proper about 60μ ; penis directed diagonally downward, nearly straight except for slightly curved base.

This insect has been described from a number of specimens, mounted and unmounted, including material on timothy (*Phleum pratense*) from Wooster, Ohio, June, July, and August 1944, the first and last lots forwarded for study by J. S. Houser, the July lot collected by Dr. F. W. Poos (holotype and paratypes); from foxtail (*Setaria viridis*) from Washington, D. C. (Mount Pleasant section), August 13 and 20 and September 3, 1944, collected by Harold Morrison (paratypes and male allotype); in grass sheaths, from Fort Lee, N. J., May 24, 1938, collected by George Rau (paratypes); and on *Poa* sp., Portland, Oreg., May 12, 1944 (No. 16271) collected by George C. Anderson and James Roaf. In addition, specimens on Fescue grass from State College, Pa., October 25, 1941, collected by Keil, although all preadult stages, are considered to be this species, as are adult females on *Festuca rubra* in field, collected at State College, Pa., in 1942 by Keil (received through G. F. Ferris). The types are in the U. S. National, collection of Coccidae.

The relationships of this species have been indicated in the key to species, and in the discussion under *Heterococcus borkhsenii*. The New Jersey specimens examined are very similar to the material from Ohio; the specimens from the District of Columbia seem to average a little lower with respect to numbers of pores on various parts of the body, but no basis has been found thus far for a suspicion that they might be specifically distinct from the Ohio specimens.

Heterococcus nudus (Green)

First described in 1926 (11, p. 172) as a *Phenacoccus*, this species was transferred two years later by its author (12, p. 21) to *Heterococcus*. The only subsequent references of significance that have come to attention are by Goux (6, p. 332; 7, p. 63; 8, p. 256), who found the species in southern France.

Assuming the full accuracy of all details of the original description and figures, we may distinguish the species easily from others included in the genus, as shown in the key.

Green's specimens came from undetermined

grasses taken at Camberly, England; Goux's, from *Holcus lanatus* collected at Courzieu, Rhone Department, France.

Heterococcus occidentalis, n. sp.

Fig. 50

Adult female.—Very similar to *graminicola* in size and organization of pores, ducts, and setae but differing sharply in respect to appearance and dimensions of anal ring and anal lobe apical setae, these in all specimens examined much shorter and much stouter in appearance than with *graminicola*. Size as mounted up to 2.93 mm by 1.63 mm; elongate elliptical, broadly rounded at ends. Antennae characteristic, lengths of one in microns: I, 40; II, 44; III, 36; IV, 23; V, 24; VI, 23.6; VII, 28; VIII, 32; IX, 44; sensory seta on VII often curved and twisted, that on VIII about 28μ long, those on IX about 24μ long. Eye with outside dimensions of base around 24μ by 8μ . Legs characteristic, posterior with an obscure pattern of tiny clear pores as in other species, and with maximum lengths of parts of one in microns as follows: Trochanter, 64; femur, 153; tibia, 140; tarsus, 84; claw, 19.5; tarsal digitules, 21; claw digitules, 20; claw denticle present but often inconspicuous. Beak characteristic, length of one 68μ , width 72μ . Spiracles characteristic. Dorsal ostioles quite inconspicuous. Usually only the apical two pairs of cerarii definitely recognizable, spines in anal lobe cerarii about 17μ long, with 10–12 quinqueloculars adjacent, and one to two stiff body setae associated; penultimate cerarii less developed, and cerarian traces on next two anterior segments of abdomen rather obscure. Anal lobes not developed, apical seta short, usually heavy, observed length range from 44μ to a maximum of 68μ , ventral subapical seta likewise stout, about 28μ long, perhaps six additional scattered ventral setae, approximating 16μ in length. Anal ring with setae short, observed maximum 40μ , many between 30μ and 36μ , some of normal shape, but many flattened and split apically, as if composed of two setae fused together for most of their lengths. Quinqueloculars widely distributed, general distribution of multiloculars as in *graminicola*, along margins and dorsally and ventrally in abdominal area; numbers very variable, observed range of total marginal multiloculars 120–225, dorsal and ventral about as in *graminicola*, but variable; small tubulars similar,

but somewhat fewer. Body setae likewise similar, observed range of middorsal 5–10 μ , maximum observed midventral 24 μ , all somewhat stiffer than with *graminicola*.

This species is based on a few mounted and unmounted specimens collected August 28, 1940, on grass at Yakima, Wash., by F. W. Carlson. These are so very close to *graminicola* that a decision was made to describe them only after long consideration. The extraordinary condition of the anal ring and anal lobe setae surely is due, in part at least, to molting difficulties of some sort at the time of change from preadult to adult, but this would not with certainty account for all the differences that appear in these structures, since the few in the material examined that approximate normal condition are likewise much shorter and stouter than corresponding structures in *graminicola*.

The types are in the U. S. National collection of Coccidae.

Laingiococcus, n. g.

Adult female.—Appearance in life uncertain. Broad elliptical, flattened dorsally and ventrally, posterior apex broadly notched. Size medium, length 2 mm; derm membranous throughout. Antennae 9-segmented, apical segment short, not enlarged, with two sensory setae, preapical with one. Eyes developed. Legs not unusual, claw with distinct denticle, tarsal digitules acute, not attaining claw apex, claw digitules longer, extending well beyond tip of claw, knobbed at apices. Beak described as 1-segmented. Spiracles not unusual. Dorsal ostioles described as absent. No cerarii of any sort developed, at most with evident clusters of large body setae on margins of terminal abdominal segments. Anal lobes broadly rounded protrusions, apical seta not differentiated. Anal ring removed from the body apex, appearing dorsal, presumably with six setae, each half narrow, apparently with a single pore row. With circular quinquelocular pores on both surfaces, and multilocular disk pores on posterior abdominal segments. Body setae numerous, some large, stiff, some small, slender. A single transversely elliptical ventral cicatrix.

Type of genus.—*Heterococcus painei* Laing (15, p. 20).

The preceding description has been based entirely on the description of the genotype (15). Laing's placement of this species in *Heterococcus* has been accepted as the starting point for

its reassignment to a related new genus, but it should be noted that the description contains certain discrepancies which, if verified, may prove barriers to the assumed close relationship. Thus the described absence of dorsal ostioles and of all traces of cerarii, the occurrence of an unsegmented beak (perhaps a question of interpretation of structure), and (from its illustration) the narrow anal ring with only a single pore band all depart widely from the basic pseudococcine structure exhibited by the other genera here discussed.

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